

National Geodetic Survey

NGS SUPPORT FOR REAL-TIME POSITIONING



2008 CORS USERS FORUM
CGSIC - SAVANNAH, GA
SEPTEMBER 16, 2008



Bill Henning, Senior Geodesist, PLS.



A complete survey crew



National Oceanic and Atmospheric Administration

OVERALL PROGRAM OBJECTIVE

- Ensure that geodetic issues are adequately addressed in operation and use of real-time positioning systems

**APPLICATION: TO ENSURE THE
PROPER GEODETIC BASIS FOR
ACCURATE RT POSITIONING
ALIGNED TO THE NSRS**

The National Geodetic Survey 10 Year Plan Mission, Vision and Strategy 2008-2018

<http://www.ngs.noaa.gov/INFO/tenyearfinal.shtml>

The mission of NGS is hereby understood to be:

1) To define, maintain and provide access to the **National Spatial Reference System** to meet our nation's economic, social, and environmental needs

and

2) To be a world leader in geospatial activities, including the development and promotion of **standards, specifications, and guidelines.**

http://www.ngs.noaa.gov/INFO/StrategicPlan_20080810.pdf



GPS/GNSS POSITIONING

PASSIVE MONUMENTS

ACTIVE STATIONS

STATIC

NGS 58/59 GUIDELINES

FGDC ACCURACY STDS.

MFTRS. SOFTWARE & DOCS.

RTN

VRS MAC FKP

½ COST OR DOUBLE WORK DONE
OPERATORS DRAFT GUIDELINES

≈ 75 IN USA, 200+ WORLDWIDE

**"OPERATING AN RTN-
CHAP. 1" DRAFT**

REAL-TIME

SINGLE BASE MONUMENTS

CLOSEST BASE CORS

NGS CLASSICAL USER GUIDELINES-DRAFT

REAL-TIME ACTIVITIES AT THE NGS

- I. OPERATE AN NTRIP CASTER.**
(Fed. Owned/operated – currently 7 - soon 9.
RTCM 2.3 & 3.x, From Foundation CORS. NO
CORRECTORS)
- II. DEVELOP AND PUBLISH GUIDELINES
DESCRIBING BEST PRACTICES IN RTK & RTN .**
(RTK Users draft, RTN Operators draft, etc.)
- III. PARTICIPATE IN MEETINGS, FORUMS,
WORKSHOPS, ETC., CONCERNING REAL-TIME
NETWORKS. SEEK LEADERSHIP ROLES.**
(FIG, FGCS, ESRI, ACSM, RTCM, etc.)
- IV. RESEARCH PHENOMENA AFFECTING
ACCURATE REAL-TIME POSITIONING.**
(Orbits, refraction, multipath, antenna
calibration, and crustal motion.

NGS SUPPORT FOR REAL-TIME POSITIONING

WHAT'S HAPPENED THE LAST YEAR?

- APPROVED NGS POLICY
- STREAMING RTCM 2.3 & 3.0 DATA VIA NTRIP – 7 CORS
- DRAFT USER GUIDELINES FOR CLASSICAL RT POSITIONING RELEASED
- DRAFT RTN OPERATORS GUIDELINES IN-HOUSE VETTING
- FIG COLLABORATION ON INTERNATIONAL GUIDELINES
- NGS= ANALYSIS CENTER FOR IGS ORBITS
- RTN TEAMS FORMED – WORKGROUPS, FGCS
- REAL-TIME NGS WEB SITE IN PRODUCTION
- RELEASED HTDP 3.0
- “IDOP” INTRODUCED
- 20 WORKSHOPS (ESRI, ACSM, FIG, STATES, ETC.)



I. NGS Real Time Stream Team

Product Manager

Richard Snay



<mailto:ngs.realtime.gnss@noaa.gov>

Outreach and User Relations

Bill Henning



Pam Fromhertz

CORS Data Streams

Charlie Schwarz



Neil Weston



Giovanni Sella

IT / Software Development Team

Bruce Sailer



Hong Chen



Sky Chaleff

NGS HEADQUARTERS



HNPT
Cambridge, MD
Looking South
2004/11/30



**NGS TESTING SITES – CORS
STATIONS HNPT, MDSI,
VAGP, VITH, PRMI, BARH
ON LINE SOON = ESPT, CORB**

DAILY REPORTS

NTLOGPARSER Report

=====
===== - Generated:
realtime:/usr/local/ntrip
First Log Message: Sun J
Mon Jan 7 03:00:00 200
=====
===== STREAM AVA

01. MOUNT: /HNPT Total
Percentage: 100.00% Ur
wgeorg)

02. MOUNT: /HNPT1 Tot
Percentage: 100.00% Ur

03. MOUNT: /MDSI Tota
Percentage: 100.00% Ur

04. MOUNT: /MDSI1 Tot
Percentage: 100.00% Ur

05. MOUNT: /PRMI Total
Percentage: 99.99% Uni

MOUNT: /VAGP Total Tir
Percentage: 100.00% Ur

07. MOUNT: /VIKH Total
Percentage: 99.91% Uni

Total Time Available: 14:
Unique Users: 2 (rcarlos

Mount Logins Time Connected

/HNPT 2 2879 min 45 sec*
/MDSI 3 4319 min 26 sec*
/VAGP 2 2879 min 37 sec*

02. USER: mchris

Mount Logins Time Connected

/MDSI1 1 1437 min 45 sec

03. USER: rcarlos

Mount Logins Time Connected

/PRMI 14 1439 min 00 sec*
/VIKH 12 1438 min 47 sec*
/VITH 9 1437 min 34 sec*

04. USER: sbruce

Mount Logins Time Connected

/HNPT 1440 45 min 42 sec
/HNPT1 1440 18 min 13 sec
/MDSI 1440 47 min 25 sec
/MDSI1 1440 19 min 55 sec
/PRMI 1440 56 min 10 sec
/VAGP 1439 47 min 11 sec
/VIKH 1438 51 min 31 sec
/VITH 1436 63 min 45 sec

05. USER: ujeremy

Mount Logins Time Connected

/HNPT 2 1439 min 55 sec
/MDSI1 3 1439 min 53 sec
/VAGP 2 1439 min 58 sec*

06. USER: wgeorg

Mount Logins Time Connected

/HNPT 1 1439 min 24 sec

UNAUTHORIZED ACCESS ATTEMPTS ----- ***

NO UNAUTHORIZED ACCESS ATTEMPTS TO REPORT ***



NGS WEB PAGES – CURRENTLY TEST/BETA

NGS Realtime GNSS: NTRIP Service

NGS Realtime GNSS Data Service

User Registration for NGS Realtime GNSS Data Service (Prototype)

Please complete this form to apply for free access to real-time GNSS data streams from the NGS NTRIP Caster at realtime.ngs.noaa.gov (port 2101).

User data (* mandatory): [NGS privacy policy](#)

Full Name*:

Organization*:

City*:

State/Country*:

ZIP Code : (5 numbers,
required only if country is
US)

Phone :

E-mail*:

The login information you will receive by email in response to your request is only valid for your personal use.

DISCLAIMER

The NTRIP service being offered by NGS is in test and evaluation mode (prototype). NGS makes no claim, direct or implied, that the data streams will be uninterrupted, consistent or entire.

☐ I have read and accepted the disclaimer.

National Geodetic Survey (NGS)

Maryland, U.S.A

ngs_realtime_gnss@noaa.gov

Date Last Updated: April 18, 2008

[NOAA Privacy Policy](#)

[NGS NTRIP Service Disclaimer](#)



National Oceanic and Atmospheric Administration

II. THE TWO DIRECTIONS OF REAL-TIME NETWORK POSITIONING



- I. TOP DOWN: Overall Administrator's viewpoint- Alignment to the NSRS, coordinates, adjustments, Network spacing, Site requirements, Communication issues, Personnel, Cost/Benefit analysis, \$\$\$\$, Partners



- II. USER UP: Best methods- Field techniques, GNSS knowledge, Knowing datum requirements, Knowing accuracy requirements, Calibrations, Applications, Data management

WHY SINGLE-BASE?

- ACCOMMODATE LEGACY USERS
- CLOSEST BASE NETWORKS
- AREAS WITH NO CELL COVERAGE
- PROJECT SITE APPLICATIONS, SUCH AS MACHINE CONTROL

WHY EMPIRICAL?

- PLETHORA OF VARIABLES
- TIMELINESS
- PORT TO RTN USERS
- DYNAMIC NATURE OF RT POSITIONING

<http://www.ngs.noaa.gov/>

*NATIONAL GEODETIC SURVEY
USER GUIDELINES
FOR CLASSICAL
REAL TIME GNSS POSITIONING*



v. 2.0.3 September 2008

William Henning, lead author


RT ISSUES – SUCH AS:

- ✓ PDOP
- ✓ RMS
- ✓ # SVNS
- ✓ BASELINE LENGTH
- ✓ REDUNDANCY
- ✓ # BASES
- ✓ OBS TIMES
- ✓ EQUIPMENT
- ✓ LATENCY
- ✓ FIXED/FLOAT
- ✓ ELEVATION MASK
- ✓ LOCALIZATIONS
- ✓ ACCURACY/PRECISION
- ✓ SPACE WEATHER
- ✓ GEOID QUALITY
- ✓ QA / QC
- ✓ GPS / GLONASS




NGS HOME PAGE

<http://www.ngs.noaa.gov/>




National Geodetic Survey



NGS, Positioning America for the Future

U.S. Department of Commerce



National Oceanic and Atmospheric Administration
National Ocean Service

[aeronautical data](#) [CORS / OPUS](#) GPS data [datasheets](#) Find a Survey Mark [geodetic tool kit](#) [download software](#)

Search for [Go](#)

[Site Map](#)
[What We Do](#)
[Products & Services](#)
[State Advisors](#)
[NGS Newsletter](#)
[Our History](#)
[FAQ](#)
[Employment Opportunities](#)
[Contracting Opportunities](#)
[Project & Division pages](#)
[Geoid](#)
[Geosciences Research \(GRD\)](#)
[Remote Sensing](#)
[FGCS/GIAC](#)
[Height Modernization](#)
[GPRA/County](#)

Tuesday, July 8, 2008

Upcoming Events

06/23/2008 - IGS Workshop presentations posted
NGS hosted the IGS Analysis Center Workshop 2008 in Miami Beach during 2-6 June 2008. All of the available presentations (oral and poster) have been posted [here](#).


05/19/2008 - New Version of the Horizontal Time Dependent Positioning Tool
NOAA's National Geodetic Survey recently released version 3.0 of the HTDP software for transforming positional coordinates and/or geodetic observations across time and between spatial reference frames.... [more](#)

05/06/2008 - Real Time User Guidelines Draft Released
NGS has released for public comment the draft of single-base real-time positioning techniques, procedures and technical information to help users achieve accurate, consistent coordinates for their real-time applications. NGS is currently working on subsequent releases of additional guidelines for the users and administrators of real-time networks (RTN), especially in regard to the importance of keeping them aligned to the NSRS. [more](#)

03/11/2008 - Bluebook Data Submission Policy Addendum Released
Beginning June 15th, 2008, NGS will only accept projects which have been adjusted to the current realization* of the NAD 83 in the survey area. ... [more](#)

03/11/2008 - The National Readjustment
A new FAQ page has been added [here](#)

REAL TIME NETWORKS (RTN)

- 
- PERHAPS OVER 75 RTN EXIST IN THE USA WITH MANY IN THE PLANNING STAGES
 - HOW ARE THEY ESTABLISHED?
 - HOW ARE THEIR COORDINATES COMPUTED? ARE THEY CONSISTENT?
 - HOW IS THE NETWORK ADJUSTED?
 - ****HOW DOES THE RTN ALIGN TO THE NSRS?**
 - CAN USERS USE ANY MANUFACTURERS' EQUIPMENT IN THE RTN?
 - DO OVERLAPPING NETWORKS GIVE THE SAME COORDINATES?
 - WHAT ARE THE FIELD ACCURACIES?

REAL-TIME CONSIDERATIONS

- **PASSIVE / ACTIVE**
- **DATUMS & ADJUSTMENT EPOCHS**
- **GEOID + ELLIPSOID / CALIBRATE**
- **SINGLE BASE / RTN**
- **GNSS / GPS**
- **GRID / GROUND**

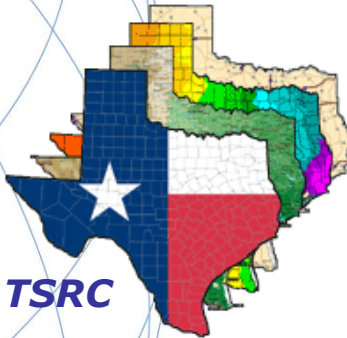
Guidelines for Operating a Real-Time GNSS Network

CHAPTER ONE -Achieving Consistency Among Positional Coordinates and Velocities

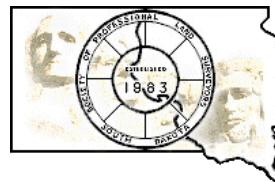
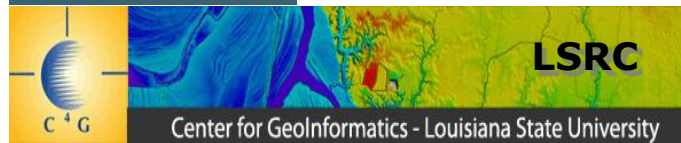
- ITRF 2000 or NAD 83
3 recommendations:
- #1 Include a subnetwork of the RTN into the National CORS network.
- #2 For each reference station contained in the RTN, adopt values for its 3-dimensional positional coordinates (at a selected epoch date) and a velocity that are consistent with corresponding values adopted by NGS for reference stations in the National CORS network.
- #3 For each reference station in the RTN, use the Online Positioning User Service (OPUS) at <http://www.ngs.noaa.gov/OPUS/> to test for the continued consistency of its adopted positional coordinates and velocity on a daily basis, and revise the station's adopted coordinates and/or velocity if the tests reveal a need to do so.



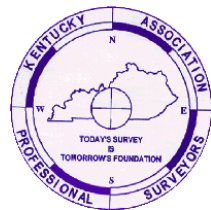
III. OUTREACH, COOPERATIVE EFFORTS AND LEADERSHIP



TSRC



FEMA



The Delaware Association of Surveyors



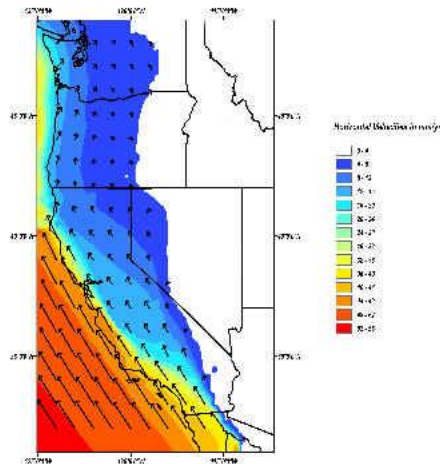
National Oceanic and A

+ PUBLIC & PRIVATE **RTN ADMINISTRATORS** SPANNING
MORE THAN 35 STATES

IV. HTDP 3.0- REFERENCE STATION VELOCITIES



HTDP - Horizontal Time Dependent Positioning



Horizontal velocities across the western United States. Colors specify speed in mm/yr and arrows specify corresponding directions of motion relative to the North American Datum of 1983.

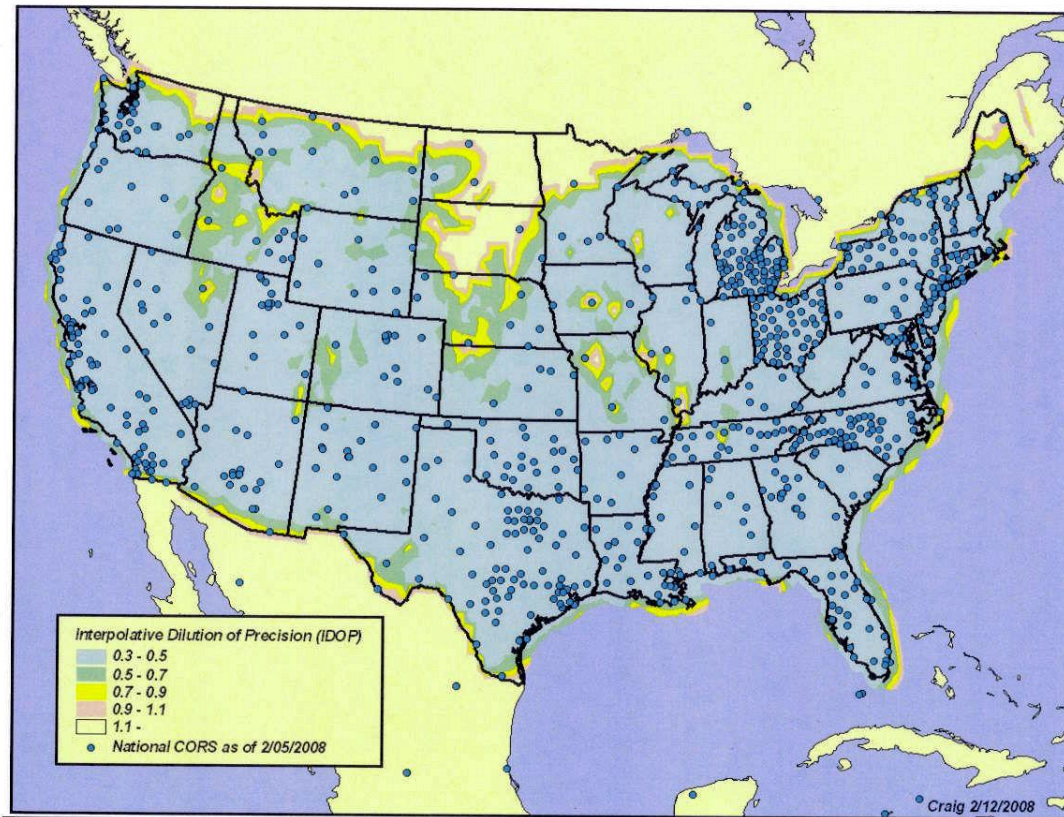
The HTDP software enables users to predict horizontal displacements and/or horizontal velocities related to crustal motion in the United States and its territories. The software also enables users to update positional coordinates and/or geodetic observations to a user-specified date. HTDP supports these activities for coordinates in the North American Datum of 1983 (NAD_83) as well as in all official realizations of the International Terrestrial Reference System (ITRS), and all official realizations of the World Geodetic System of 1984 (WGS_84). Hence this software may be used to transform geodetic coordinates between any pair of these reference frames in a manner that rigorously addresses differences among the definitions of their respective velocity fields.

The software employs models that address both the continuous and the episodic components of crustal motion. For characterizing continuous motion, the models assume that points on the Earth's surface move with constant horizontal velocities. This assumption is generally acceptable except for the accelerated motion experienced during the years immediately following a major earthquake and for the motion associated with volcanic/magmatic activity. For characterizing the episodic motion associated with earthquakes, the models use the equations of dislocation theory.

"IDOP" – CAN BE APPLIED TO RTN

OPUS-RS Coverage

Interpolative Dilution of Precision (IDOP) Values



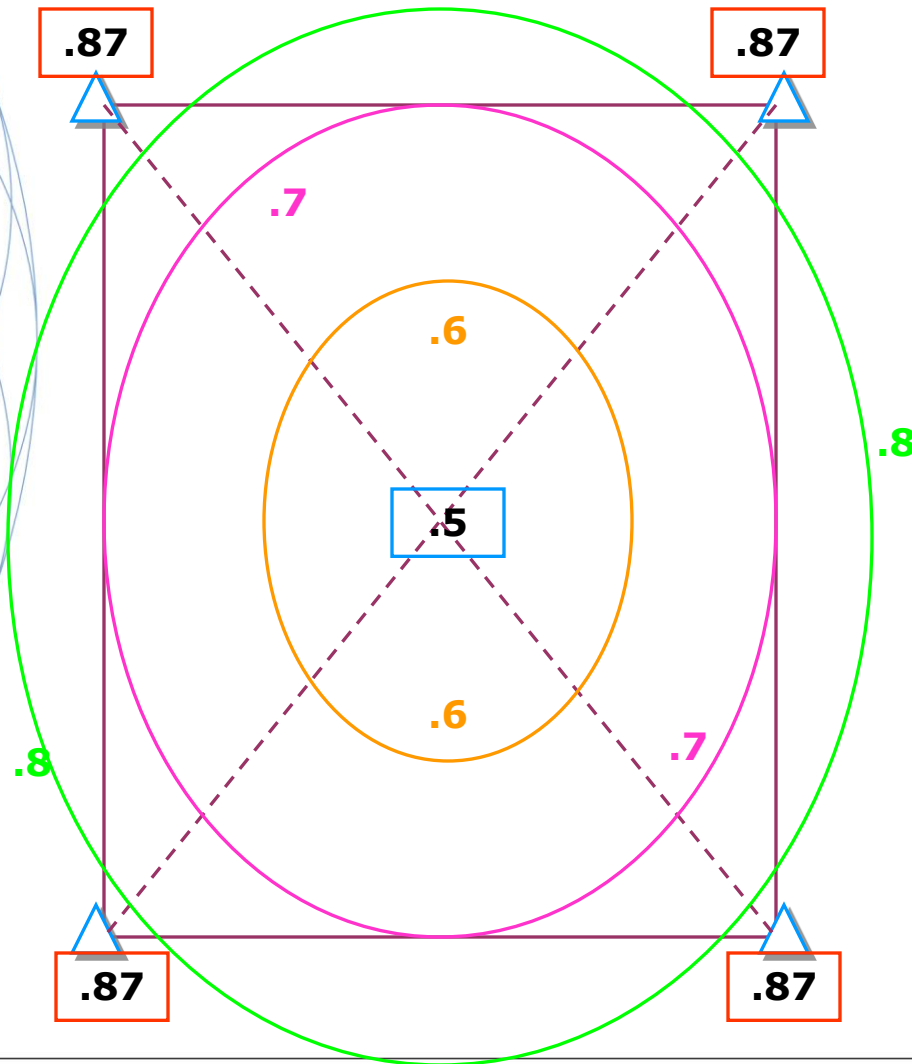
IDOP + SCALE WILL CORRELATE TO ACCURACY

IDOP VALUES – 4 CORS EXAMPLE

$$\text{BEST IDOP} = \frac{1}{\sqrt{N}}$$

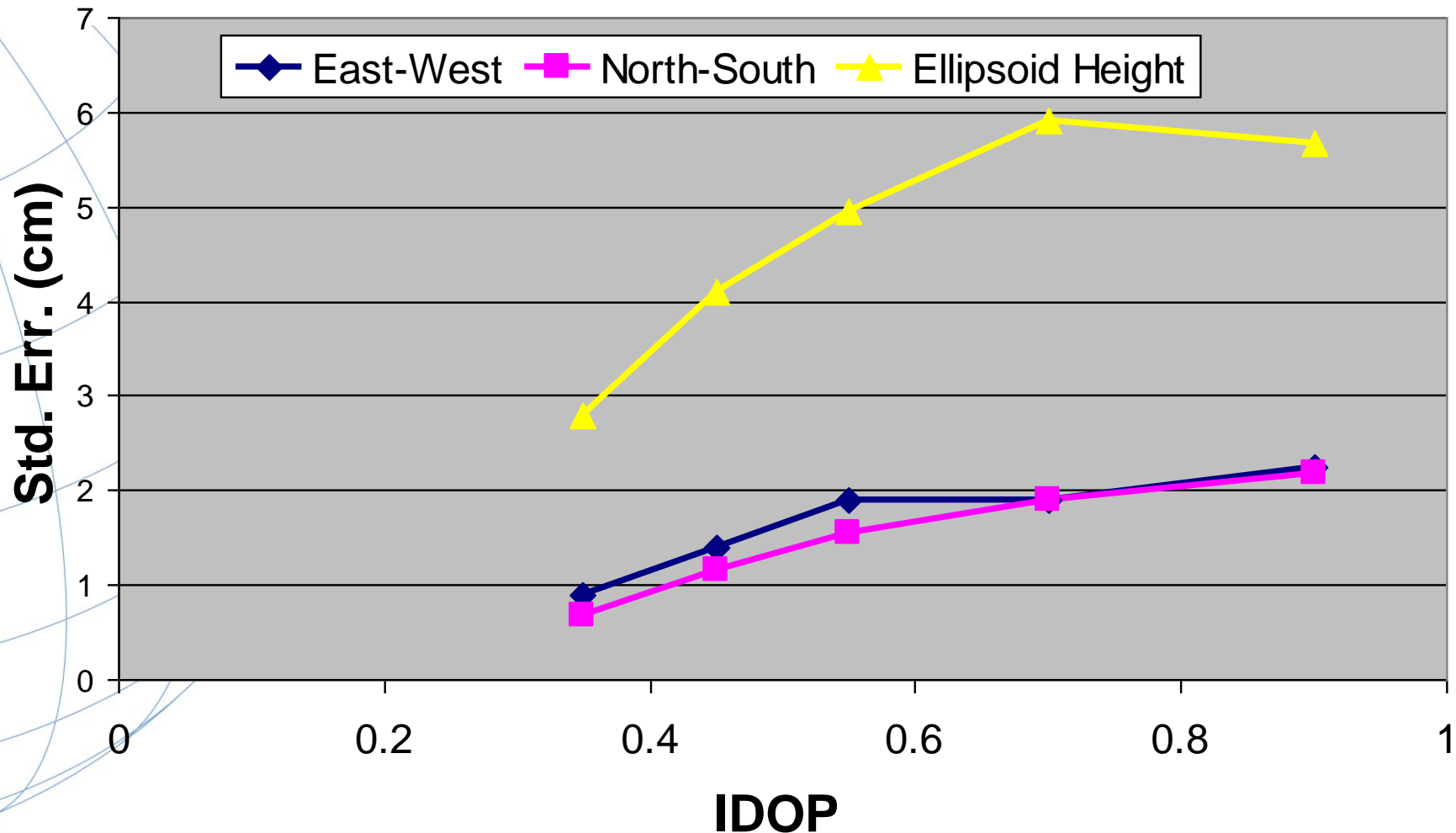
THEREFORE, WITH
9 CORS, THE IDOP
AT THE CENTROID
WOULD BE .33,
WITH 4 CORS IT
WOULD BE .5 AT
THE CENTROID

ADDITION OF RMS
OF DISTANCE TO
CORS
CONTRIBUTING
TO THE SOLUTION
GIVES FINAL
UNITLESS
NUMBER



**"IDOP" WILL
BE THE
SUBJECT OF A
FORTHCOMING
PAPER BY DRS.
RICHARD SNAY,
TOM SOLER
AND CHARLES
SCHWARZ**

OPUS-RS Accuracy for 15-minute data sets



NGS RT CONTACTS (HEADQUARTERS)

- RICHARD.SNAY@NOAA.GOV
REAL-TIME POSITIONING PROJECT LEAD
- GIOVANNI.SELLA@NOAA.GOV
NATIONAL CORS DIRECTOR
- WILLIAM.HENNING@NOAA.GOV
REAL-TIME POSITIONING- COORDINATION & OUTREACH